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RESEARCH DESIGNS & STANDARDS ORGANIZATION

Manak Nagar, Lucknow-226011



Document No.: T-52

Indian Railway Standard Specification for Ultrasonic Testing of Rails/Welds
using Vehicular Systems Revised - 2020

Amendment History:

S.N.	Amendment Date	Version	Reasons for Amendment
1.	15.04.2009	1.0	First issue of Specification April, 2009
2	20.02.2020	2.0	Revision in Under reporting and Over reporting criteria and deletion of Border line OBS and developed OBS defect. Rail Cum Road Vehicle is included in Type of Vehicle.

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INDIAN RAILWAY STANDARD SPECIFICATION FOR ULTRASONIC TESTING OF RAILS/WELDS USING VEHICULAR SYSTEM REVISED - 2020

1. Scope:

This specification applies to the ultrasonic testing of rails in service to detect and locate internal rail defects for BG track of Indian Railway using vehicular test systems. The ultrasonic testing shall comprise of testing by vehicle based system followed by manual verification process to classify the defects for actions such as protection and/or removal.

2. Standards:

'Manual for Ultrasonic Testing of Rail and Welds –2012' along with its latest revision and updated correction slips (referred as '**Manual**' here in after) at the time of opening of the tender shall be the reference standard for deciding the classification of the rail/weld defect besides 'Indian Railway Standard Specifications for Ultrasonic Testing of Rails/Welds (Provisional), Revised, 2012' along with its latest revision and updated correction slips (referred as '**Specification I**' here in after). Where other standard(s)/specification(s) is/are referred in this specification, the revision of that standard(s)/specification(s) current at the time of calling tenders shall be used. In case additional correction slips are issued to the Manual, during the pendency of the tender/contract, the test procedure/criteria shall have to be suitably updated in consultation with technical representative.

3. Definition of terms:

The terms and definitions used in the specification are placed in **Annexure 1**. The list is indicative and not exhaustive. Please also refer **Annexure 1 of Specification I**.

4. Technical Representative:

Please refer **Specification I**.

5. Defective condition of rails to be tested

5.1 Rail defect definition:

Please refer **Specification I**.

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5.2 Rail Defect Management:

5.2.1 Rail testing:

5.2.1.1 Frequency of Rail Testing by Vehicular USFD System:

The USFD testing interval shall be as per Para 6.6.1.1 of the **Manual**. Any change in USFD testing frequency, if required shall be decided by the concerned Zonal Railways in consultation with the RDSO. The manufacturer/service provider, here in after referred as 'Firm', shall ensure the availability of adequate resources to ensure Ultrasonic testing of the rail as per various requirements of this Specification, **Manual and Specification I**. The locations and intervals of testing shall be as directed by the Divisional Engineer (DEN)/ Senior Divisional Engineer (Sr. DEN).

5.2.1.2 Scanned Area:

Please refer **Specification I**.

5.2.2 Weld Testing:

This shall mean testing of weld as rail during through pedestrian testing by SRT /DRT of rail and reporting of defect accordingly as per provisions of the **Manual**.

5.3 Rail defect classification:

5.3.1 Sensitivity setting:

The sensitivity setting of the USFD equipment used for manual verification shall be done as specified in the **Manual**.

5.3.2 Defect Classification

The defects in the rails shall be classified as per the criteria given in the **Manual**.

5.4 Rail/Weld defect action requirements:

These shall be as specified in the **Manual**.

5.5 Defect identification requirements: These shall be as per the specification 1, However, the bright yellow colour shall be used for spot verified defects from the suspect list of vehicular testing and red colour for defect identified during through Manual testing.

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6 Testing system performance requirements:

6.1 Benchmarking

6.1.1 The vehicular USFD test system shall be benchmarked by Zonal Railway. On request of Zonal Railway, benchmarking can also be carried out by RDSO instead of Zonal Railway. The benchmarking shall be carried out as per provisions contained in **Annexure 2**.

6.2 Minimum defect detection levels

6.2.1 The vehicular USFD test system should conform to the following performance requirements when operated at the minimum speed of 40 Kmph or higher as determined during benchmarking:

Performance Parameter	Type of Defect	Requirements
Under Reporting	IMR / IMRW	Nil
	OBS / OBSW	≤ 5%
Over reporting	Overall	≤ 500 %

Defects shall be classified as per **Manual** only after manual verification and action for defects be taken accordingly. The under reporting and over reporting shall be calculated as per method mentioned in **Annexure 5** of this specification.

6.3 Performance verification of benchmarked Vehicular system during regular testing

6.3.1 The capability of the test system shall be verified at an interval as laid down in **Para 6.3.2** to ensure compliance to the performance requirements specified in **Para 6.2** above in respect of under reporting and over reporting.

6.3.2 This shall be done on randomly selected test stretch of total length as mentioned in the table below. The test stretch may consist of more than one stretch and should be representative of the track tested by the Vehicular USFD system, including locations (if existing) such as those having rail surface defects of wheel burn, scabs, squats etc. where a test rig with two 45° probes is being used for detection of transverse flaws in rail head as per the procedure mentioned in the **Manual**.

Through testing of the test stretch by RDSO approved Single Rail Tester or Double Rail Tester (make and model) of Zonal Railway shall be undertaken jointly by the firm and Zonal Railway, such that the delay between vehicular testing and the Manual through testing is generally not more than half of testing interval as specified in the Para 6.6.1.1 of the **Manual**. To compute under reporting levels, rail/weld failures due to defects which can be

detectable by ultrasonic technique shall also be taken into account. The under reporting and over reporting shall conform to requirements specified in **Para 6.2.1**. If required physical examination by breaking open the defects which were may also be undertaken. Pedestrian spot verification would be carried out with sufficient accuracy. No False reporting of defects would be permitted during the pedestrian spot verification.

S.N.	Cumulative testing by the Vehicular USFD system	Test Stretch length
1	2000 TKM	50 TKM for each 1000 TKM of testing.
2	More than 2000 TKM and Upto 4000 TKM	20 TKM for each 1000 TKM of testing.
3	More Than 4000 TKM	10 TKM for each 1000 TKM of testing.

Performance level shall be calculated on cumulative length of test stretch as mentioned in the table above.

6.3.3 Railways shall prepare a report of each of the test checks performed in accordance with Para 6.3.2 above within three days after completion of test check. Any deterioration in the performance of vehicle noticed during test checks shall be immediately investigated by the firm and firm shall take remedial measure for the same. Zonal Railway may consult RDSO on remedial measures being taken by the firm. In case of Under-Reporting of defects in IMR category, repeat test of the corresponding complete stretch shall be carried out by the firm either by the Manual USFD system (SRT/DRT) or by Vehicular USFD system. No additional payment would be made to the firm for such a repeat test. Due to time gap between the test check after the vehicular USFD testing as specified in Para 6.3.2 of this specification, there may be possibility that some OBS defects of large size may get converted into IMR during this period. Zonal Railway would take this into account while advising the firm for repeat test.

6.3.4 Increase in testing speed shall form an objective of the Railways in order to improve utilization of track possession. For this purpose, a vehicle shall be permitted for testing on revenue track if it exhibits performance levels specified in **Para 6.2.1** at a minimum testing speed of 40 Kmph or higher during the benchmarking.

6.3.5 The increase in testing speed beyond 40 Kmph is being aimed at by IR. As such an attempt will be made to validate the technology of the firm at testing speeds higher than 40 Kmph. For this purpose, the speed of the vehicle will be increased in increments of 5 Kmph as per methodology prescribed in

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Annexure 4 and technology of the firm at the highest speed for which the criteria laid in **Para 6.2.1** is fulfilled, will be deemed to have been validated.

- 6.3.6** Sizing of suspects shall be calculated and reported by the software tool of the vehicular USFD system. Subsequent to spot verification, the B-Scan and A-Scan recorded during manual spot verification and sizing as reported by software tool of vehicular USFD system shall also be submitted to the Railway. In order to estimate flaw growth rate, above records of previous runs along with current run shall also be submitted to the Railway. In case of contractual work or Outsourcing work of Vehicular USFD, submission of above details along with sizing of defects as reported by software tool of vehicular system shall be submitted by the firm.

7. Operators certification:

Provisions of **the Specification I** shall apply.

8. Assessment of capability of equipment and operator

The capability of the vehicular ultrasonic test system shall be assessed by benchmarking study, which shall be carried out either by the Zonal Railway or by the RDSO as mentioned in the para 6.1 of this specification. Whereas operator's competency shall be adjudged as per **Specification 1**.

Vehicle USFD operator shall have valid Level II certification in UT from any National / International Nondestructive Testing Society / Institute / Training Center along with Regular Competency Certificate issued by RDSO for Through Rail and Weld Testing manually by SRT and DRT. In addition to it, **vehicle USFD operator** shall undergo training in the vehicular USFD system by the Original Equipment Manufacturer (O.E.M) and shall have certification regarding this training by the O.E.M.

Analyst shall have valid Level II certification in UT from any National / International Nondestructive Testing Society / Institute / Training Center along with Regular Competency Certificate issued by RDSO for Through Rail and Weld Testing manually by SRT and DRT. In addition to it, **Analyst** shall undergo training for analyzing the data recorded by vehicular USFD testing system by the Original Equipment Manufacturer (O.E.M) and shall have certification regarding this training by the O.E.M.

Position of **Vehicle USFD operator** and **Analyst** shall be manned by different individuals and sufficient number of **Vehicle USFD operator** and **Analyst** shall be deputed to carryout Vehicular USFD testing and analysis within a time frame as specified in the respective Para of this specification.

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9. Recording of Data:

- 9.1** The vehicular ultrasonic testing system must continually record the ultrasonic test responses of the rail to the impulses of the testing transducers on all channels in B-Scan and shall be monitored in real time. It should be possible to view 'B-Scan' representation as well as 'recreated A-Scan' (from the recorded B-Scan data) representation for any suspect location. Facility for run on run comparison of the 'B-Scan' should also be available.
- 9.2** The vehicular system should be provided with in built GPS facility for locating the suspect location along with B-Scan. The GPS coordinates shall be invariably mentioned for all the suspects and reportable defects.
- 9.3** Location of the suspect and reportable defects (confirmed after spot verification) shall also be indicated with reference to telegraph post or OHE mast numbers along with chainage as per provisions of **Specification I**.
- 9.4** The backup of rail testing data shall be possible to be downloaded on desktop computer to allow analysis at the later stage.
- 9.5** Rails that have not been tested on turnouts and other locations shall be recorded and reported. If such circumstances arise in the test work (where the limitation on the capacity of the testing system to identify defects in specific common track situations actually prevents reliable testing), then the start and end points of these conditions which prevent reliable testing should be identified clearly in the test exception report and be annotated to the overall comments to field on the daily test report.

10. Documentation and Reporting:

- 10.1** Documentation and reporting all information shall be recorded as specified below.

- 10.1.1** Daily test report giving a summary of the particular day testing shall be prepared on conclusion of the testing for the day i.e. on day D.

- Date and Time of start of the testing.
- Name of the vehicle USFD operator.
- Division
- Block section.
- Line-Single Line/UP/DN/SL/NL/3L/4L
- Rail section (52 Kg/60 Kg).
- Location of starting and finishing of testing as per convention.
- Log of operating ultrasonic parameters for each run along with any changes and reasons e.g. change in gain due to temperature recalibration etc.

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- Railways employee present during testing.

10.1.2 Analysis of run data would be carried out by the firm and the list of suspect shall be available for spot verification on D+1th day. Separate list shall be prepared for the locations having rail surface defects of wheel burn, scabs, squats etc. and verification of these locations shall be carried out as per the procedure mentioned in the Manual with a test rig containing two 45° probes. List of suspects and list of locations having rail surface defects of wheel burn, scabs, squats shall be made available to the Zonal Railway on D+1th day.

10.1.3 Adequate numbers of spot verifiers shall be deployed in order to complete the spot verification process by end of D+4th day. The list of actionable defects along with classification, location and other details, rail / thermit weld/flash butt weld, head/web/foot of the rail below web etc. shall also be advised by end of D+4th day. The report shall contain details as described in the documentation requirements in the **Specification I**. It is essential that the spot verification is carried out by USFD operator and machine duly certified by RDSO. Marking of defects after the spot verification of the suspects identified by the vehicular USFD system shall be carried out as per para 5.5 of this specification. Zonal Railway shall take suitable actions on these defects as per the **Manual**.

10.1.4 Movement log detailing the daily location and hours spent testing shall be maintained and submitted as per provisions of **Specification I**.

10.1.5 The list of classifiable defects including NR along with their B-Scan/A-Scan, which were confirmed in the spot verification shall be prepared and submitted in comparative format (run over run) for the test section for every subsequent testing undertaken on the track.

10.1.6 Rail test exception report which lists the stretch of track / rail that are omitted from the test program due to rail and track conditions shall be submitted on D+1th day. However, omitted locations which can be tested manually, shall be tested by the operator and report submitted on D+4th day.

10.1.7 Probe wise comparison of recorded Vehicular USFD data (peak height, horizontal movement for angular probe and peak height, loss of back wall signal amplitude along with length) with spot verification data shall also be submitted (as per proforma specified in **Annexure 6** of this specification) after completion of spot verification for the "Test Stretch" as specified in the para 6.3.2 of this specification along with any additional stretch as required either by the Zonal Railway or RDSO.

10.1.8 The above reports shall be prepared in hard and soft copy and shall be forwarded to the Junior Engineer (JE)/Section Engineer (SE)/Sr.Section Engineer (SSE) (P.Way), AEN and DEN/ Sr. DEN.

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10.1.9 The data recorded by vehicular USFD system (in electronic format) shall also be provided by the firm along with suitable software for viewing the results in the office of AEN, DEN/Sr.DEN of the section.

10.1.10 List of suspect defects shall be prepared by the analyst after analysis of Vehicular USFD testing data using suitable customized software for the same.

11 Quality Assurance Plan (For Outsourcing Work)

11.1 The firm shall also have a Quality Assurance Plan (QAP) for maintaining Analyst, vehicle USFD operator and operator records, continuous monitoring of their performance, identification of Analyst, vehicle USFD operator and operators not performing up to the mark with assessment criteria or medical (vision) criteria for operators in accordance with **Specification 1** and their withdrawal from testing, training of Analyst, vehicle operator and operators for continuous improvement in their skills etc.

11.2 In order to have a proper implementation of such QAP the firm shall have a proper quality control organization headed by a Quality Control Incharge having minimum academic qualification of Bachelor in Science or equivalent with Physics as one of the subject or Diploma/Degree in Engineering from any national/international institute/University. The person should also have:

(i) Valid Level III certification in UT from any National/International Non destructive Testing Society or Institute. In addition, he should have six months experience in Ultrasonic Testing of rails in any Railways of the world or shall have passed 5 days course in UT of Rails and Welds conducted by M&C Dte. of RDSO/Lucknow.

OR

(ii) Valid Level II certification in UT from any National/International Non destructive Society or Institute. In addition, he should have minimum three years' experience in Ultrasonic Testing in any industry and shall also have valid certificate of Regular course for Ultrasonic Testing of rails/welds, conducted by M&C Dte. of RDSO/Lucknow.

In addition to it, **Quality Control Incharge** shall undergo training in the vehicular USFD system by the Original Equipment Manufacturer (O.E.M) and shall have certification regarding this training by the O.E.M.

11.3 Periodicity of calibration and sensitivity setting for vehicular USFD system shall be specified by the firm in the QAP.

11.4 Approval of QAP shall be done by the RDSO.

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12. Others

- 12.1** The vehicular ultrasonic test system can either be Rail Bound or Rail Cum Road type self-propelled vehicle. The vehicle shall be driven either by the crew provided by Indian Railways or by the firm's crew, trained and certified by the Zonal Railway. Expenditure for training and certification of the firm's crew shall be borne by the firm. Expenditure on the Indian Railway crew (if deployed) for driving the vehicle shall be borne by the firm. The **Rail Bound** vehicular test system should have compatibility for attachment to the locomotive. For **Rail Cum Road type** (RCRV) vehicular test system, it should preferably have compatibility for attachment to the locomotive. If RCRV is not compatible for attachment with locomotive, it should be possible to expeditiously clear the track in case of breakdown and all necessary arrangements for this would be ensured by the firm.
- 12.2** The vehicular ultrasonic test system in Rail movement mode and testing mode should be compatible with latest Indian Railway Track Circuiting, Signalling Installation and axle counter system, such that it can be run in a manner similar to a train as per authority of the signalling system. Moreover, the testing / undercarriage system shall not cause any failure of these track circuits/axle counters. The vehicular ultrasonic test systems shall be designed to operate continuously without causing any interference to the signalling system.

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Annexure 1

Definitions of Terms

1. **Vehicle USFD operator:** shall mean the person responsible for operation of vehicular USFD system and its controls.
2. **Operator:** shall mean the person who shall be undertaking verification of suspects identified by Vehicular USFD system, using RDSO verified manual rail testers.
3. **Analyst:** shall mean the person responsible for undertaking processing of recorded responses received from the Ultrasonic System and identification of suspects.

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Annexure 2

Procedure for Benchmarking of Vehicular Systems for Ultrasonic Testing of Rails

1. Scope

Benchmarking of the performance of the vehicular test system shall be a pre-requisite to use the system for revenue testing on IR. This procedure details various steps required to accomplish benchmarking exercise for test vehicle for revenue testing.

2. Submission of details

Following details shall be submitted to the Zonal Railway by the vehicle manufacturer/service provider referred as '**Firm**' hereinafter:

- 2.1 Scanned area of the probe system
- 2.2 Approximate test speed of the vehicle and capability of the test system in terms of over reporting, under reporting, repeatability, minimum detectable defect size at suggested speed of testing. **(Please refer Para 6.2.1).**
- 2.3 Limitation of the test system especially covering special features/locations such as station area, bridges, level crossings, points and crossings, Switch Expansion Joints (SEJ) etc, type of track namely long welded rails/ short welded rails/ jointed track etc, surface condition of rail namely scabbed/wheel burnt rails, corrugations etc.
- 2.4 Whether analysis shall be done off line or on line
- 2.5 Time taken in submission of final defect list to Railways for action
- 2.6 Motive Power- self propelled or other wise
- 2.7 Type of vehicle- rail bound or rail cum road
- 2.8 Transmission System
- 2.9 Overall dimensions including detailed dimensioned drawings for determination of the maximum moving dimensions and infringements to **Indian Railway Schedule of Dimensions (IRSOD), 2004** with latest correction slips in transit and testing mode
- 2.10 Riding stability analysis/test results for Broad Gauge (BG) system
- 2.11 Information regarding ability to get detected by track circuits and axle counters provided on IR
- 2.12 Parameters such as axle load, center of gravity, floor height, buffer height in empty and loaded condition
- 2.13 Type of buffers and couplers
- 2.14 Wheel profile, wheel diameter
- 2.15 Suspension details
- 2.16 Relevant certificates issued by railway systems where the vehicle is/was in operation
- 2.17 Intended maximum speed of operation in transit and testing mode

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- 2.18 Limitation of the vehicle in negotiating the curves/gradients etc as mentioned in the IRSOD, 2004 with necessary correction slips
- 2.19 Limitations of the vehicle regarding coupling and movement in the train formation
- 2.20 Measures to be adopted if and when the vehicle fails/derails in the section
- 2.21 Any other information necessary for clearance of the vehicle for movement/operation on IR

3. Clearance of Vehicle for Movement

- 3.1 In case IR is satisfied with the capabilities of the system, further processing of the clearance of the vehicle for movement/operation shall be initiated.
- 3.2 RDSO / Zonal Railway shall assess the track worthiness of the vehicle based on the details submitted by the firm. If required oscillation trials for the vehicle may also have to be planned by RDSO to assess the riding behavior of the vehicle on IR track.
- 3.3 The infringements to IRSOD, 2004 shall be processed by RDSO for sanction by Railway Board through Commissioner of Railway Safety (CCRS).
- 3.4 On sanction, and completion of the trials (if required), RDSO shall issue necessary speed certificate for movement/ operation of the vehicle.
- 3.5 RDSO shall obtain necessary sanctions from Railway Board/Commissioner of Railway Safety (CCRS).
- 3.6 Firm shall provide necessary information for accomplishing above.

4. Costs

4.1 Cost to be borne by the firm

- 4.1.1 Necessary cost for import/transport of the vehicle
- 4.1.2 Trial and other incidental charges including modification etc to suit IR
- 4.1.3 Cost of technical staff of the firm for trial and data analysis
- 4.1.4 Fuel and consumables required for the vehicle during entire course of benchmarking.
- 4.1.5 Cost for necessary staff for manual spot verification of defect locations identified by vehicle. These staff shall comply provisions of **Specification I**.
- 4.1.6 Field marking of defective location
- 4.1.7 Security and protection of the vehicle
- 4.1.8 Cost of creating artificial defects in rails to be used in calibration track as per design indicated in **Annexure 3**. (Rails for this purpose shall be provided by IR free of cost to the firm).
- 4.1.9 Processing costs associated with the approval process.

4.2 Costs to be borne by IR

- 4.2.1 Stabling siding for the vehicle at RDSO and trial locations.
- 4.2.2 Cost of through verification testing for determination of performance levels.
- 4.2.3 Cost of crew and traffic possessions for the trial.
- 4.2.4 Welding and insertion of calibration rails.

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5. Benchmarking

5.1 The service provider and/or manufacturer of the vehicle shall approach Zonal Railway in this regards keeping in view the time requirements for clearances detailed in **Para 3** above.

5.1.1 This benchmarking scheme has been developed for trial of the vehicular systems for ultrasonic testing of rails in order to assess their performance on IR track. Fulfillment of the criteria specified in this scheme shall not in any way bind IR to enter in to any financial or other commitment with the firm.

5.2 The benchmarking exercise shall comprise of following stages

5.2.1 Pre initialization Stage

5.2.1.1 The vehicular system shall be primed for trial.

5.2.1.2 Selection of test stretch shall be done keeping in view the capability and limitation of the test system offered.

5.2.1.3 Scheduling and programming various activities of the trial.

5.2.1.4 Insertion of rails containing artificial defects.

5.2.2 Initialization Stage

5.2.2.1 This stage shall involve necessary exercise by the firm for setting up of the test system as per detection requirements and meeting performance levels specified.

5.2.2.2 IR shall provide necessary traffic possession for undertaking this exercise. The sub activities involved at this stage shall be:

5.2.2.2.1 Setting of optimum test parameters including calibration and sensitivity setting etc by few trial runs.

5.2.2.2.2 Determination of optimum test speed on IR track (fish plated, SWR, jointed track, station area, various critical surface conditions) by the firm. IR shall assign track stretches and provide other support as listed in **Para 4.2** for undertaking this exercise. The firm shall advise the optimum speed so determined to IR and trials shall be essentially undertaken at this speed over test stretches. (Please also refer **Para 6.2.1** of this Specification).

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5.2.3 Trial Stage

- 5.2.3.1 This stage shall comprise of real time testing and all the evaluation shall be with respect to the markings provided by the firm on the rails for individual defect classification after the test runs and follow up by the firm as per requirement. This shall comprise of:
- 5.2.3.1.1 Repeatability of detection of artificial defects (Annexure 3) shall be judged on calibration track at the speed of 30 Kmph for three runs. Vehicular USFD test system shall detect all the artificial defects on each calibration rail for each run on calibration track.
- 5.2.3.1.2 15 number trials at the benchmarking speed on calibration rail shall be conducted for determination of under reporting on calibration track (Annexure 3). Vehicular system shall have performance levels as specified in Para 6.2.1 of this specification.
- 5.2.3.1.3 Test runs at benchmarking speed and Ultrasonic testing parameters on given test stretch/section. Test stretch shall be of minimum 25 Km total length. Minimum three runs shall be undertaken at the benchmarking speed advised by the firm.
- 5.2.3.1.4 Marking of defects on rails as per defect classification criteria prescribed in the Manual and additional criteria prescribed by RDSO, if any.
- 5.2.3.1.5 Through testing by IR using SRT / DRT for determination of the performance levels.

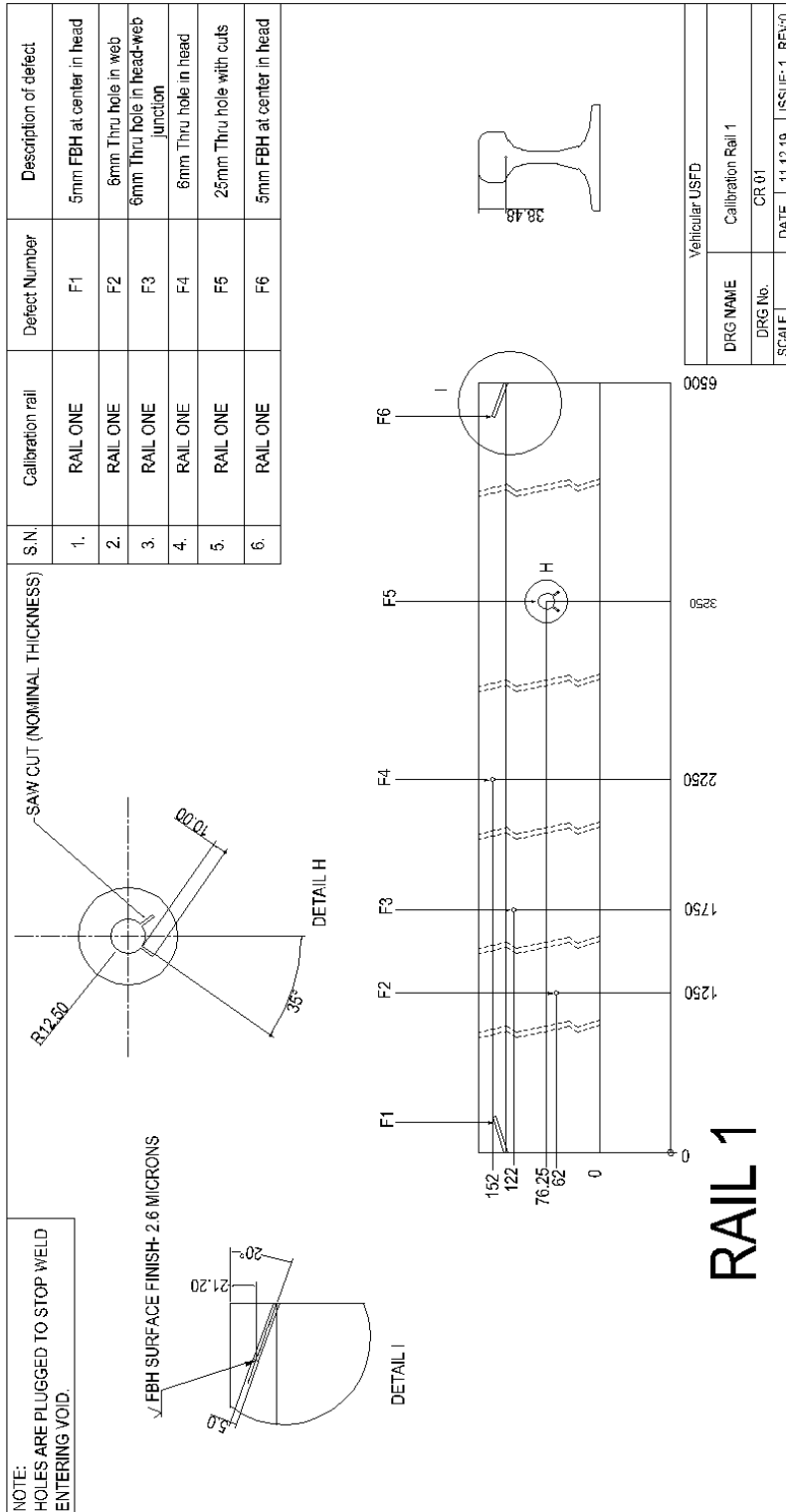
5.2.4 Performance Levels

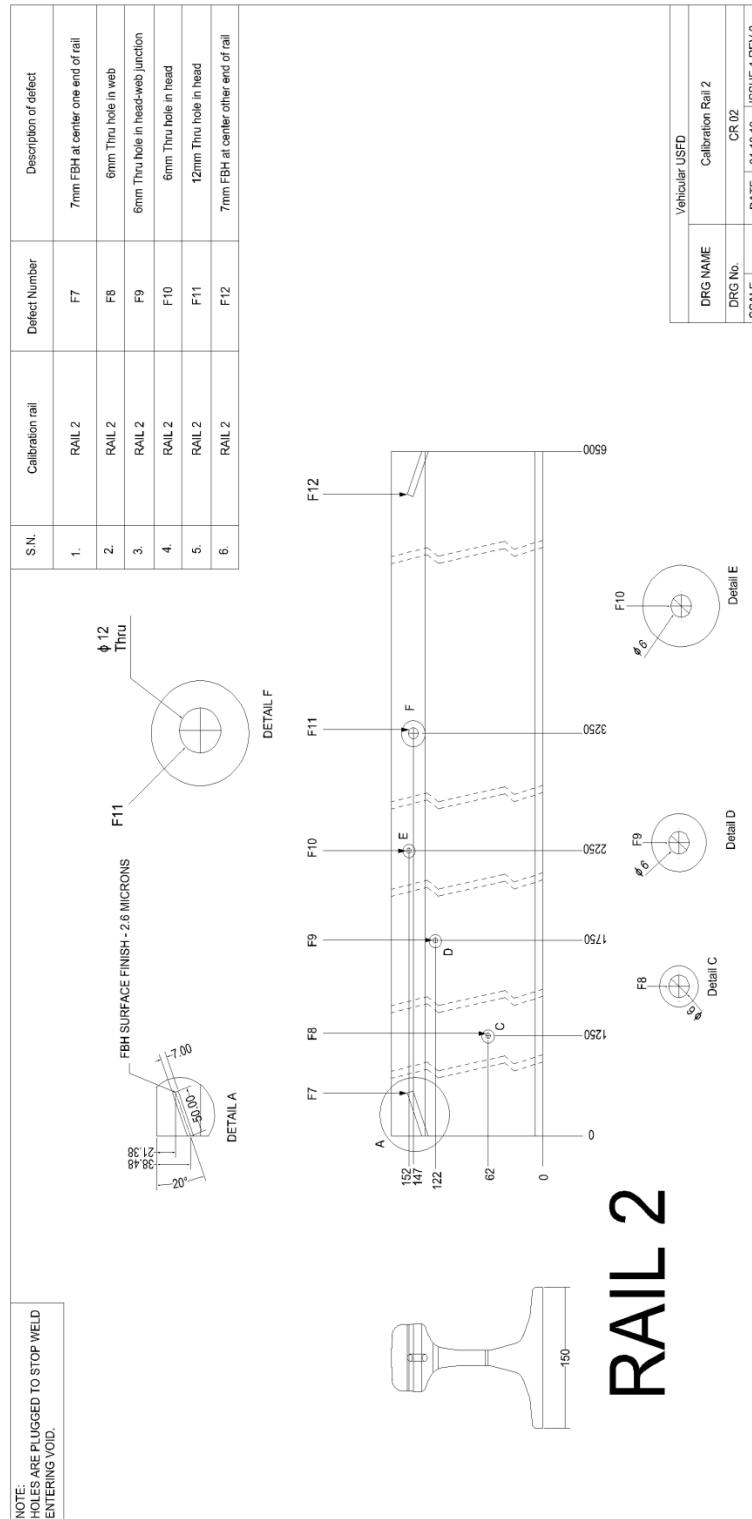
- 5.2.4.1 IR shall determine repeatability level and performance levels (with reference to **Para 6.2.1** of this specification such as levels of under reporting and over reporting) based on verification testing as specified in Para 5.2.3 of this Annexure. The system would be treated as successfully benchmarked if requirements in terms of repeatability and performance level are met with. Necessary assistance in analysis of the data shall be provided by the firm.
- 5.2.4.2 IR shall determine average track possession time required per Km of testing.
- 5.2.4.3 B/A-Scan reporting vis-à-vis flaw location, run-over-run analysis and database shall be provided for each run in soft copy and hard copy both to IR by the firm.
- 5.2.4.4 After benchmarking of the vehicular USFD system, the firm will test 100 to 250 TKM by the vehicular USFD on the representative track and check the performance level of the system as per para 6.2.1 of this specification. Based on the results of the above testing necessary adjustment, if required, shall be made by the firm before undertaking the regular testing. In case, the Vehicular USFD system (The Same UT system and the same vehicle) has already performed satisfactorily on Indian Railway Network, the testing specified in under this para 5.2.4.4 need not be carried out. No payment needs to be made to the agency for testing other than regular testing.

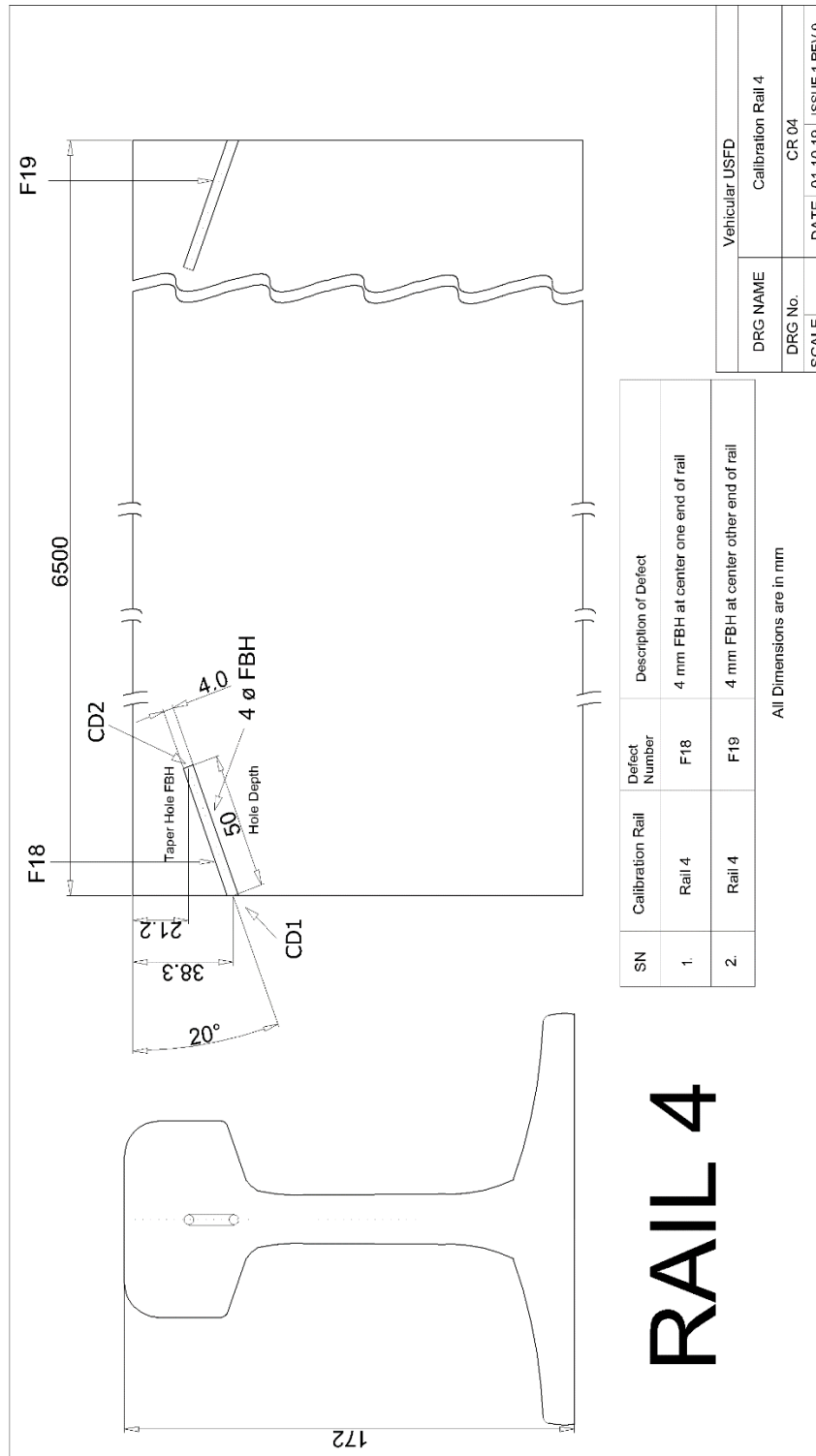
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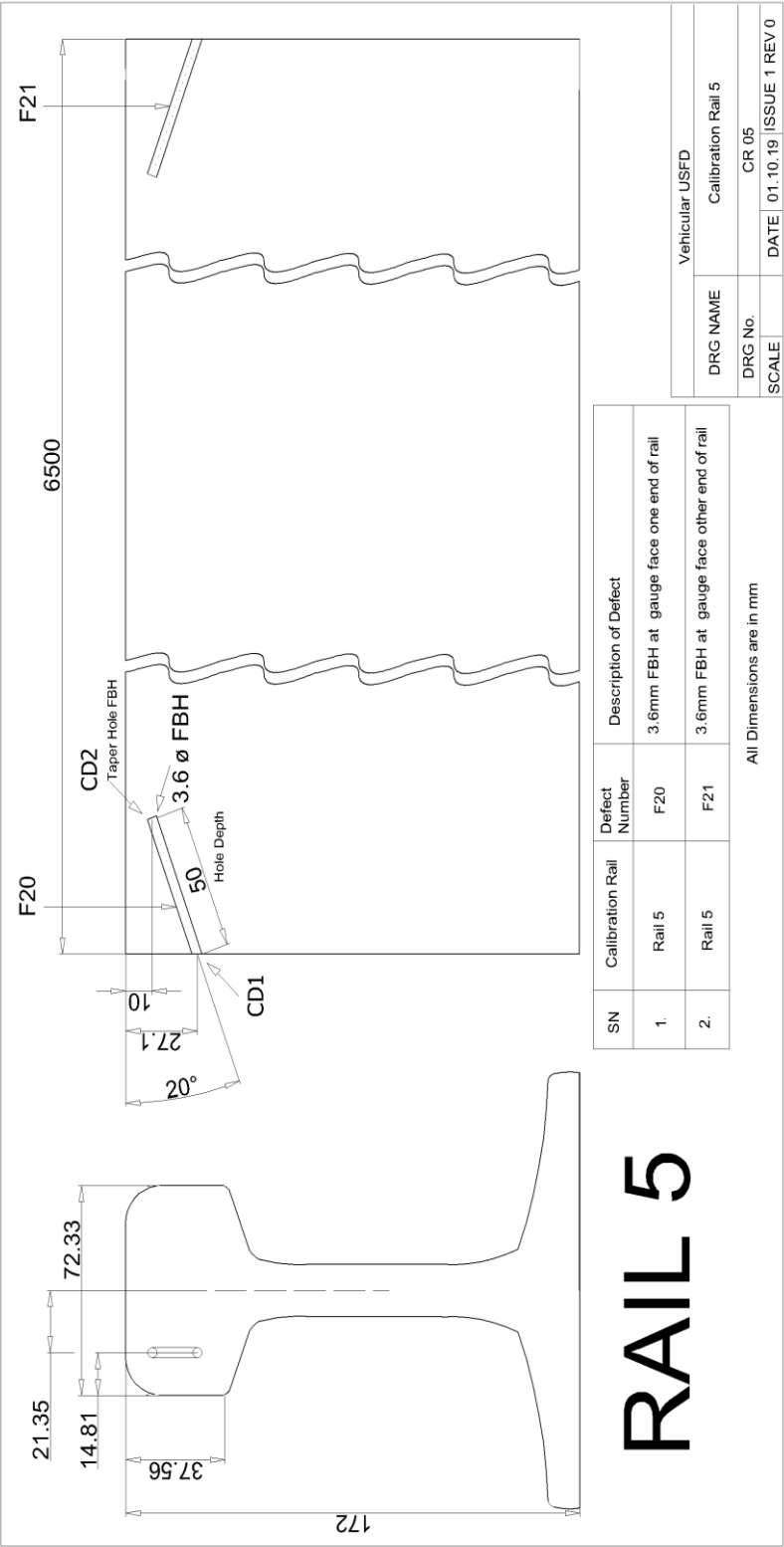
Annexure 3

Calibration Track Containing Artificial Defects



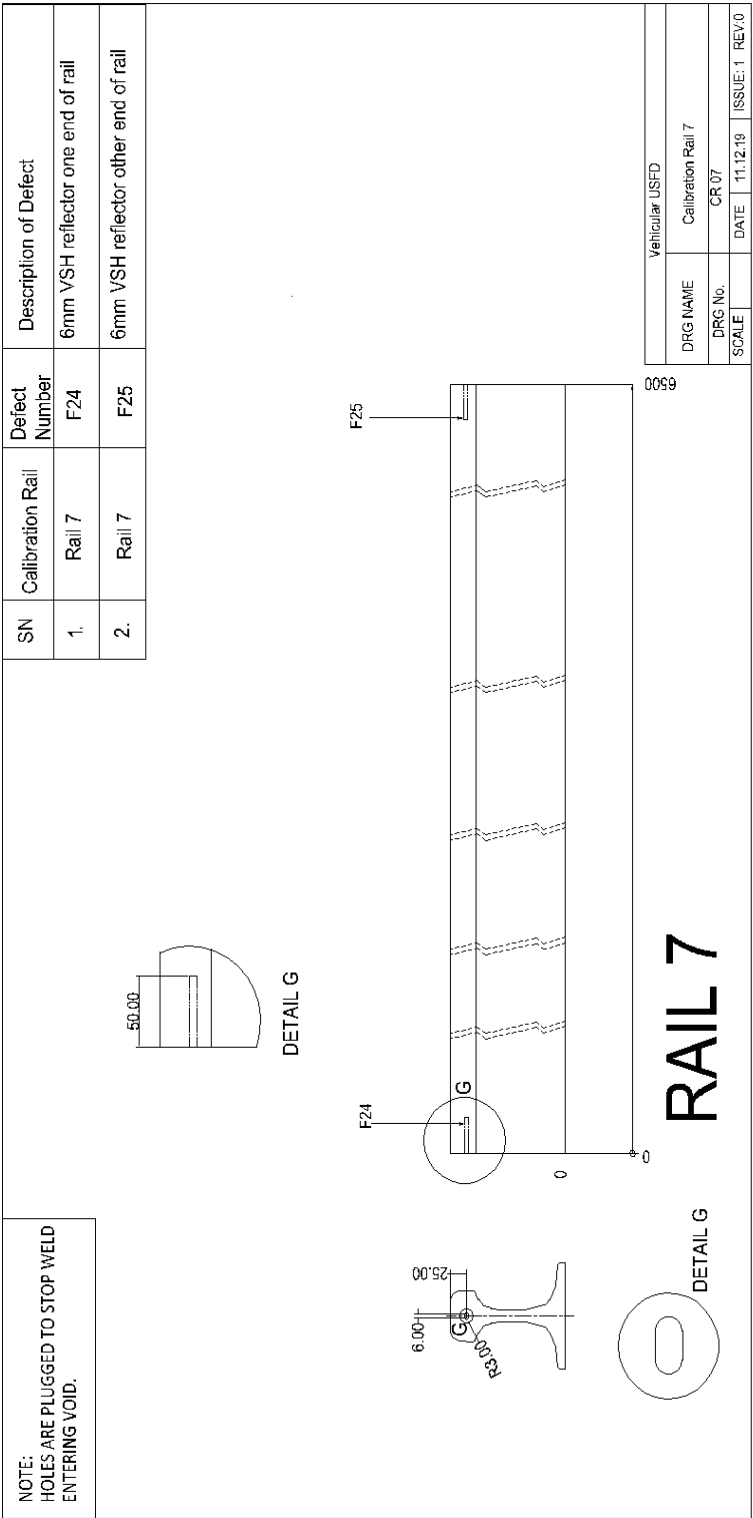








Vehicular USFD	
DRG NAME	Calibration Rail 6
DRG No.	CR 06
SCALE	DATE
ISSUE 1	REV 0



List of defects on calibration track: For each side of rail, one set of calibration rails shall be prepared and inserted in the Track.

Calibration Rail - 1

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail one	F1	5 mm FBH at center in head one end of rail
2	Rail one	F2	6 mm Thru hole in web
3	Rail one	F3	6 mm Thru hole in head-web junction
4	Rail one	F4	6 mm Thru hole in head
5	Rail one	F5	25 mm Thru hole with cuts
6	Rail one	F6	5 mm FBH at center in head other end of rail

Calibration Rail - 2

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail two	F7	7 mm FBH at center one end of rail
2	Rail two	F8	6 mm Thru hole in web
3	Rail two	F9	6 mm Thru hole head-web junction
4	Rail two	F10	6 mm Thru hole head
5	Rail two	F11	12 mm Thru hole in head
6	Rail two	F12	7 mm FBH at center other end of rail

Calibration Rail - 3

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail three	F13	5 mm FBH at Non-Gauge face one end of rail
2	Rail three	F14	5 mm FBH at Non-Gauge face other end of rail
3	Rail three	F15	25 mm Thru hole with saw cut in web
4	Rail three	F16	5 mm FBH at Gauge face one end of rail
5	Rail three	F17	5 mm FBH at Gauge face other end of rail

Calibration Rail - 4

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail four	F18	4 mm FBH at center one end of rail
2	Rail four	F19	4 mm FBH at center other end of rail

Calibration Rail - 5

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail five	F20	3.6 mm FBH at Gauge face one end of rail
2	Rail five	F21	3.6 mm FBH at Gauge face other end of rail

Calibration Rail - 6

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail six	F22	3.6 mm FBH at Non-Gauge face one end of rail
2	Rail six	F23	3.6 mm FBH at Non-Gauge face other end of rail

Calibration Rail - 7

S.N.	Calibration Rail	Defect Number	Description of defect
1	Rail seven	F24	6 mm VSH reflector one end of rail
2	Rail seven	F25	6 mm VSH reflector other end of rail

For calculation of repeatability on Calibration rail defect at 30 KMPH following artificial defects on calibration rail shall be considered

S.N.	Calibration Rail	Defect No.	Description of defect
1	Rail one	F1	5 mm FBH at center in head one end of rail
2	Rail one	F2	6 mm through hole in web
3	Rail one	F3	6 mm through hole in neck
4	Rail one	F4	6 mm through hole in head
5	Rail one	F5	25 mm through hole with cuts in web
6	Rail one	F6	5 mm FBH at center in head other end of rail
7	Rail two	F7	7 mm FBH at center one end of rail
8	Rail two	F8	6 mm through hole in web
9	Rail two	F9	6 mm through hole in neck
10	Rail two	F10	6 mm through hole in head
11	Rail two	F11	12 mm through hole in head
12	Rail two	F12	7 mm FBH at center other end of rail
13	Rail three	F13	5 mm FBH at NG face one end of rail
14	Rail three	F14	5 mm FBH at NG face other end of rail
15	Rail three	F15	25 mm through hole with saw cut in web
16	Rail three	F16	5 mm FBH at G face one end of rail
17	Rail three	F17	5 mm FBH at G face other end of rail
18	Rail four	F18	4 mm FBH at center one end of rail
19	Rail four	F19	4 mm FBH at center other end of rail
20	Rail five	F20	3.6 mm FBH at Gauge face one end of rail
21	Rail five	F21	3.6 mm FBH at Gauge face other end of rail
22	Rail six	F22	3.6 mm FBH at Non-Gauge face one end of rail
23	Rail six	F23	3.6 mm FBH at Non-Gauge face other end of rail
24	Rail seven	F24	6 mm VSH reflector one end of rail
25	Rail seven	F25	6 mm VSH reflector other end of rail

For calculation of under-reporting on Calibration rail defect at Benchmarking speed (Minimum 40 KMPH) following artificial defects on calibration rail shall be considered

S.N.	Calibration Rail	Defect Number	Description of defect	Represented Defect
1	Rail one	F1	5 mm FBH at center in head one end of rail	Developed OBS (70° central forward probe)
2	Rail one	F2	6 mm through hole in web	OBS (0° probe)
3	Rail one	F3	6 mm through hole in neck	OBS (0° probe)
4	Rail one	F4	6 mm through hole in head	OBS (0° probe)
5	Rail one	F5	25 mm through hole with cuts in web	OBS (Any Angular probe calibrated for Range of full rail height for detection of bolt hole crack)
6	Rail one	F6	5 mm FBH at center in head other end of rail	Developed OBS (70° central backward probe)
7	Rail two	F7	7 mm FBH at center one end of rail	IMR (70° central forward probe)
8	Rail two	F8	6 mm through hole in web	OBS (0° probe)
9	Rail two	F9	6 mm through hole in neck	OBS (0° probe)
10	Rail two	F10	6 mm through hole in head	OBS (0° probe)
11	Rail two	F12	7 mm FBH at center other end of rail	IMR (70° central backward probe)
12	Rail three	F13	5 mm FBH at NG face one end of rail	IMR (70° non-gauge forward side probe)

13	Rail three	F14	5 mm FBH at NG face other end of rail	IMR (70°non-gauge backward side probe)
14	Rail three	F15	25 mm through hole with saw cut in web	OBS (Any Angular probe calibrated for Range of full rail height for detection of bolt hole crack)
15	Rail three	F16	5 mm FBH at G face one end of rail	IMR (70° gauge forward side probe)
16	Rail three	F17	5 mm FBH at G face other end of rail	IMR (70° gauge backward side probe)
17	Rail four	F18	4 mm FBH at center one end of rail	Borderline OBS(70° central forward probe)
18	Rail four	F19	4 mm FBH at center other end of rail	Borderline OBS (70° central backward probe)
19	Rail five	F20	3.6 mm FBH at G face one end of rail	OBS (70°gauge side forward probe)
20	Rail five	F21	3.6 mm FBH at G face other end of rail	OBS (70° gauge side backward probe)
21	Rail six	F22	3.6 mm FBH at NG face one end of rail	OBS (70°non-gauge side forward probe)
22	Rail six	F23	3.6 mm FBH at NG face other end of rail	OBS (70°non-gauge side backward probe)
23	Rail seven	F24	6 mm VSH reflector one end of rail	IMR (0° probe)
24	Rail seven	F25	6 mm VSH reflector other end of rail	IMR (0° probe)

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Annexure 4

Methodology for Increasing the Testing Speed

1. The increase in test speed after benchmarking is based on premise of improvement in performance levels at reporting stage on account of familiarity with the test stretch with repeat runs and optimization in the setting of machine parameter for the type of track based on the knowledge of defects in track.
2. Entire test stretch offered for the vehicle shall be divided into segments in such a way that track and traffic conditions on the segment remain fairly uniform.
3. Increase in test speed shall be considered segment wise.
4. In view of above, Zonal Railways shall report performance levels to RDSO for each of the runs undertaken on these segments.
5. The normal test check frequency and test stretch length is prescribed in the specification at Para 6.3.2. Normal test check frequency is specified for every 1000 TKM. In case the segment length is less than 1000 TKM, the test check on test stretch length as specified in para 6.3.2 shall be undertaken after completing each run on the segment.
6. The vehicle shall be operated at the benchmarked speed of 'X' Kmph over the segment. (X=40, if test speed is benchmarked at 40 Kmph).
7. Test stretch length shall be selected at random from the tested track in the segment. Manual through testing shall be undertaken with RDSO approved SRT/DRT machines for determination of performance levels on this stretch.
8. If performance levels conform or are found superior to provision of **Para 6.2.1**, the next run shall be undertaken at 'X' Kmph speed as per Step 9 below. If performance levels are inferior to provisions of Para 6.2.1, further efforts for increase in speed shall be discontinued reverting back to speed at which performance parameters satisfy provisions of **Para 6.2.1**. In such case, the testing on the track segment shall be immediately undertaken at the speed at which performance parameters satisfy provisions of **Para 6.2.1**, minimum testing speed being 40 Kmph. Steps 7 and 8 shall be repeated for the next run, till four runs are completed satisfactorily at 'X' speed.
9. Decision on increase in test speed by 5 Kmph or otherwise shall be taken by RDSO / Zonal Railways taking in account performance levels observed during last three runs.
10. In case increase in test speed is granted by RDSO, steps 6 to 10 above shall be repeated at 'X+5' Kmph.

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Annexure 5

Method of calculation for Over Reporting and Under Reporting in a stretch

1. Over Reporting

S.N.	Description	Symbol
1	Total No of Suspects reported by vehicular testing	N

All the suspects from vehicular testing shall be spot verified and categorized as under

S.N.	Description	Numbers of defects in the Category
1	IMR / IMRW	X_1
2	OBS / OBSW	X_2
3	Other than above (No defect, NR*, GCC etc)	X_3
5	Total	$N = X_1 + X_2 + X_3$

$$\text{Over Reporting in Percentage} = \frac{X_3}{(N - X_3)} \times 100$$

In case of number of suspects is ≤ 5 in the test stretch as specified in Para 6.2.1 even if there is no defect identified in the spot verification, over reporting criteria should be considered as complied with.

2. Under Reporting

Through testing of the stretch shall be carried out by the RDSO approved SRT / DRT and all the defects are tabulated as under

S.N.	Description	Symbol
1	IMR / IMRW defects	T_1
2	OBS / OBSW defects	T_2

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Under Reporting in Percentage for the IMR / IMRW = $\frac{T1-X1}{T1} \times 100$

Under Reporting in Percentage for the OBS / OBSW = $\frac{T2-X2}{T2} \times 100$

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Annexure 6

Comparison of recorded Vehicular USFD data with Spot Verification data

1	2	3	4	5	6
S.N.	Section	Date of Vehicular Testing	Suspect Location(GPS)	Probe wise recorded data of vehicular testing*	Date of Spot Verification

7	8							
Suspect location (Chainage)	Probe wise recorded data of Spot Verification by SRT/DRT							
	0° Probe		70° Center Forward Probe		70° Center Backward Probe		70° Gauge Face Forward Probe	
	Loss of Back wall echo / Flaw echo amplitude	Length	Peak Height	Horizontal Movement	Peak Height	Horizontal Movement	Peak Height	Horizontal Movement

8					
Probe wise recorded data of Spot Verification by SRT/DRT					
70° Gauge Face Backward Probe		70° Non-Gauge Face Forward Probe		70° Non-Gauge Face Backward Probe	
Peak Height	Horizontal Movement	Peak Height	Horizontal Movement	Peak Height	Horizontal Movement

***Recorded Vehicular USFD data:** -Peak height & Horizontal movement for angular probe and peak height & loss of back wall signal amplitude along with length for normal probe shall be indicated in separate column for all individual vehicular USFD probe.